## Duke Solar Near-Term Projects

# *Thermal Storage Needs*

## *Wide Range in Project Sizes*

- *50 MWe (Nevada)*
- *1 MWe (Arizona)*
- *100 kWe (in development)*

# *Nevada Power and Sierra Pacific: 50 MWe*

## *No Storage*

# 1 MWe ORC Plant in Arizona
# 300 C, ORC System

## Nexant Report: Table 10
## Thermal Storage System Characteristics for the 1,000 kWe Plants

| Type and Fluid | Inventory density, kg/m$^3$ | Inventory specific heat, kJ/kg-°C | Unit tank volume, m$^3$-°C/kWht | Unit storage cost [1], $/kWht | Relative storage cost |
|---|---|---|---|---|---|
| *Two Tank* | | | | | |
| Caloria | 688 | 2.70 | 1.94 | 33 | 1.00 |
| Binary salt | 1,910 | 1.49 | 1.26 | 43 | 1.30 |
| | | | | | |
| *Thermocline* [2] | | | | | |
| Caloria/quartzite [3] | 2,172 | 1.23 | 1.35 | 19 | 0.58 |
| Binary salt/quartzite [4] | 2,465 | 1.18 | 1.24 | 34 | 1.03 |

Short-term storage (< 3 hrs) may be important

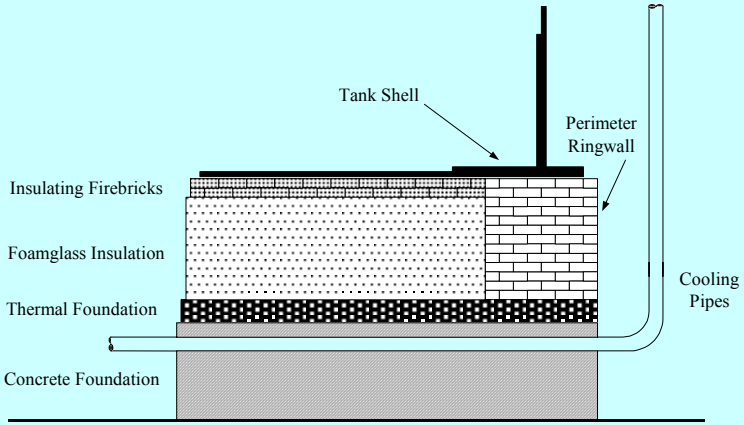
Installation and startup during ’04

Need performance evaluation, detailed design and component spec’s

Issues: cost minimization, 2-tank only near-term option

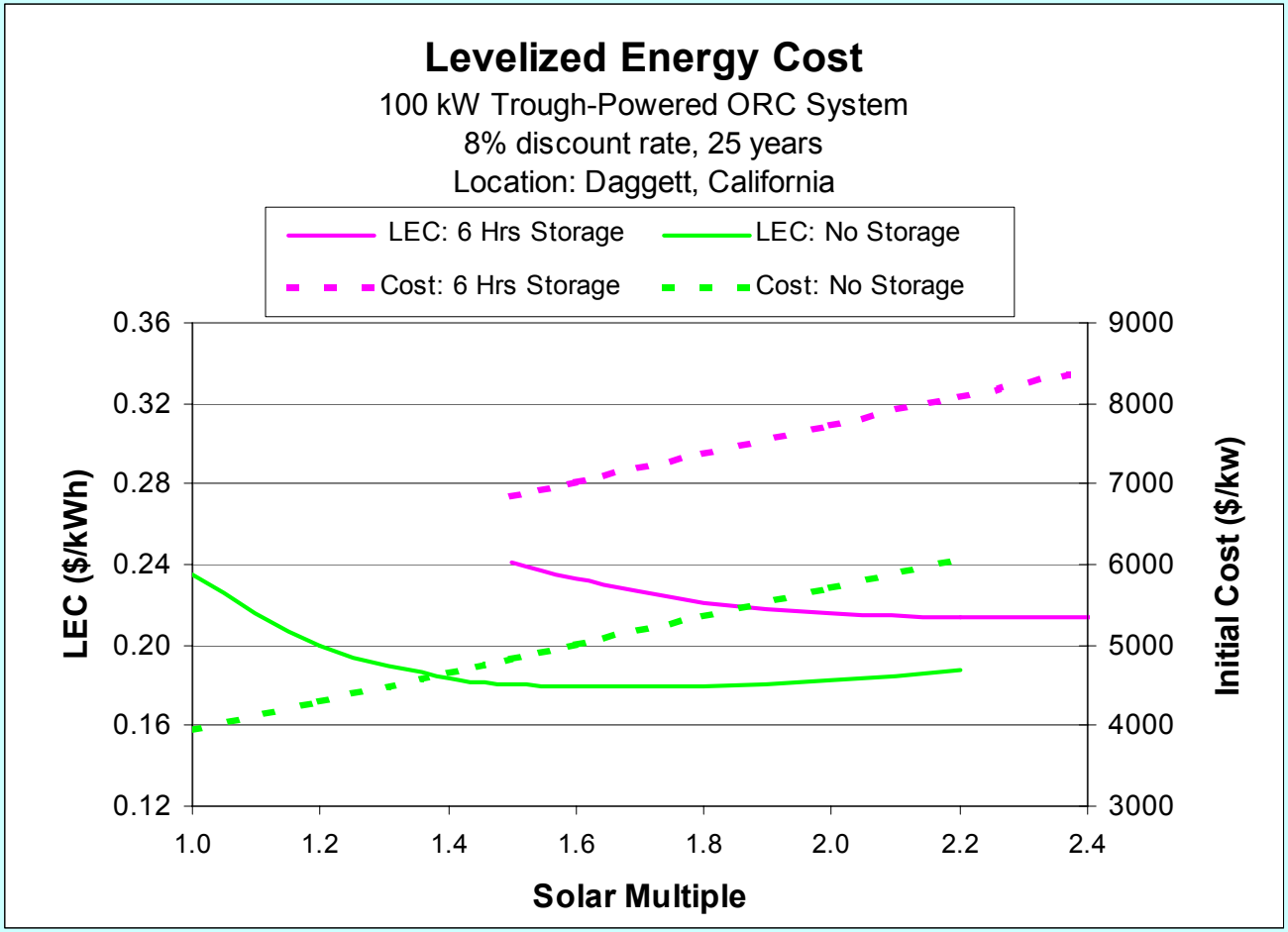
# 100 kWe and 1 MWe: 2-Tank Cost Estimates (Nexant)

| | Case 1, 100 kWe | Case 2, 1,000 kWe | Case 3, 100 kWe | Case 4, 1,000 kWe |
|---|---|---|---|---|
| Fluids | | | | |
| Collector field | Caloria | Caloria | VP-1 | VP-1 |
| Thermal storage | Caloria | Caloria | Binary salt | Binary salt |
| Temperature, C | | | | |
| Hot tank | 304 | 304 | 368 | 368 |
| Cold tank | 221 | 221 | 236 | 236 |
| Storage tanks | | | | |
| Hot | $26,000 | $107,000 | $14,000 | $57,000 |
| Cold | $25,000 | $101,000 | $14,000 | $55,000 |
| Thermal insulation | | | | |
| Hot | $17,000 | $64,000 | $10,000 | $38,000 |
| Cold | $14,000 | $52,000 | $8,000 | $29,000 |
| Foundations | | | | |
| Hot | $35,000 | $135,000 | $23,000 | $98,000 |
| Cold | $29,000 | $108,000 | $20,000 | $80,000 |
| Inventory | $36,000 | $303,000 | $28,000 | $234,000 |
| Subtotal - Storage tanks | $182,000 | $870,000 | $117,000 | $591,000 |
| Balance of system equipment | | | | |
| Oil-to-salt heat exchanger | N/A | N/A | $66,000 | $411,000 |
| Nitrate salt pumps | N/A | N/A | $20,000 | $20,000 |
| Total thermal storage system | $182,000 | $870,000 | $203,000 | $1,022,000 |
| Storage capacity, kWht | 2,860 | 26,600 | 2,570 | 23,960 |
| Unit cost, $/kWht | $64 | $33 | $79 | $43 |



# 100 kWe Trough-Powered ORC

## *Preliminary* Feasibility Results




***High-value for small systems***

*Green Power*

*Remote Sites*

**Issues**

*Costs*

*Risk*

*Thermocline*

**Timing:**

*'04 - '05*